Argonne NATIONAL LABORATORY

U.S. DEPARTMENT OF ENERGY

X-Ray Physics at High Intensity

Dr. Robin Santra, Argonne National Laboratory and University of Chicago

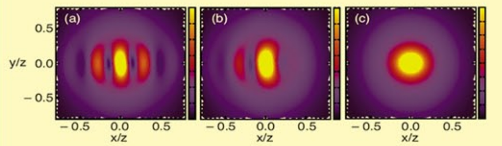
Controlling X-Ray Processes Using Intense Lasers

- The suppression of random gas-phase molecular orientations aligned along the laser electric-field axis is being exploited for both x-ray absorption and x-ray scattering. This may make it possible to perform x-ray imaging of molecules that cannot be crystallized.

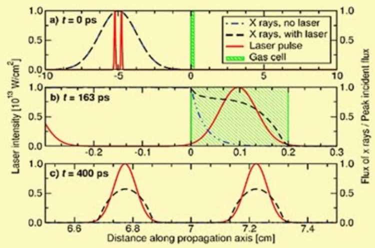
- The electronic states reached by x-ray absorption are modified, making it possible to substantially suppress x-ray absorption in an otherwise strong x-ray absorber. This may be exploited to imprint the shape of one or more laser pulses onto an x-ray pulse.

- X-ray absorption studies of laser-ionized atoms have made it possible to directly observe the spatial alignment of the orbital hole produced by the strong laser field. This work has implications for attosecond science, which aims to control the dynamics of electrons in matter.

X-Ray Scattering from Laser-Aligned Molecules



X-Ray Pulse Shaping by Laser Modification of Atoms

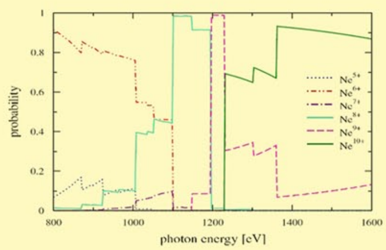


Scientific Applications of Future X-Ray Free-Electron Lasers (FEL)

- The high-intensity aspect of x-ray FEL will extend concepts of nonlinear optics and strong-field physics to the x-ray domain.

- Calculations predict that the Linac Coherent Light Source focused beam will be intense enough to ionize, in a single x-ray pulse, all 10 electrons of a neon atom.

High-Intensity X-Ray Physics Using X-Ray Free-Electron Lasers



- An understanding of x-ray/matter interaction at high intensity will be gained. This will enable the planned single-shot, single-biomolecule experiments which seek to overcome the current limitations of protein crystallography.

About Dr. Santra

Dr. Robin Santra is a theoretical physicist in the Chemical Sciences & Engineering Division at Argonne National Laboratory and an Associate Professor (part time) in the Department of Physics at the University of Chicago. His research interests focus on the ionization dynamics and inner shell physics of atoms, molecules, and clusters; strong field and electron correlation effects in the x-ray regime; and applications of x-ray free electron lasers. Dr. Santra's theoretical work complements the experimental program at Argonne's Advanced Photon Source, a U.S. Department of Energy national user facility. In addition, his work addresses important issues related to planned experimental research at fourth generation x-ray sources, in particular the Linac Coherent Light Source, which is currently under construction at the Stanford Linear Accelerator Center National Accelerator Laboratory. Dr. Santra's research supports the U.S. Department of Energy's basic science mission. Basic science brings value to society today by helping lay the foundation for tomorrow's technological breakthroughs.